University of California, Berkeley
Physics 110B, Spring 2004 (*Strovink*)

Here are some problems that should help to reinforce your understanding of vector and scalar electromagnetic potentials, and give you some practice working with them:

1.
Consider a uniform static magnetic field

$$\vec{B} = \hat{z}\, B_0 \ ,$$

where B_0 is a constant.
(a.)
Show that $\vec{B}$ can arise from the vector potential

$$\vec{A}_a = -B_0 y\, \hat{x} \ .$$

(b.)
Show that $\vec{B}$ can arise from the vector potential

$$\vec{A}_b = \tfrac{1}{2} B_0 s\, \hat{\phi}$$

(s and ϕ are cylindrical coordinates).
(c.)
By coordinate-system-independent vector analysis, show that $\vec{B}$ can arise from the vector potential

$$\vec{A} = \tfrac{1}{2}\vec{B} \times \vec{r}$$

(remember that $\vec{B}$ is constant).
(d.)
Referring to Griffiths' Eq. (10.7), find the gauge function λ that accomplishes the gauge transformation from $\vec{A}_a$ to $\vec{A}_b$.

2.
Griffiths Problem 10.3.

3.
Griffiths Problem 10.5.

4.
In free space with $\rho = 0$ and $\vec{J} = 0$, show that all four Maxwell equations can be obtained correctly if the scalar potential V is assumed to vanish, while the vector potential $\vec{A}$ satisfies

$$0 = \nabla \cdot \vec{A}$$

$$0 = \big(\nabla^2 - \frac{1}{c^2}\frac{\partial^2}{\partial t^2}\big)\vec{A} \ .$$

5.
Griffiths Problem 10.7.